# Collaborative Oceanography and Virtual Experiments

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## LONG-TERM GOALS

The long term goals are develop an online collaboration environment that supports cooperative development and operation of complex environmental field programs by distributed interdisciplinary teams. We are using these tools to facilitate ITOP virtual experiments and the ITOP field program, and packaging the collaboration tools for re-use by ONR and other entities.

## OBJECTIVES

The primary technological objectives of this effort are to provide core tools to facilitate data aggregation and discussion, to provide tools that integrate data and analysis with discussions, to provide graphical overviews that show linkages between discussions and intersections of data with discussions, and to provide these tools in a reusable package that can be easily reused in future ONR field experiments and observatories. This combination addresses a unique need of scientific collaboration, and will greatly improve the ability of investigators to rapidly understand not just data, but also the discussions and decisions based upon that data.

## APPROACH

Previous work created and demonstrated a data collection and collaboration system tailored for the Adaptive Sampling and Prediction (ASAP) component of the Monterey Bay 2006 Experiment[i]. This work is focusing on advancing the highly-tailored tools developed for prior field programs[ii], specifically COOP[iii] (the Collaborative Ocean Observatory Portal) and MOQuA[iv] (Metadata-Oriented Query and Access) into a comprehensive set of elements applicable to the ITOP and other follow-on programs.

Development is focusing on two interdependent categories: data system tools such as data collection mechanisms, data conversion, data exploration, and visualization; and human collaboration tools, such as discussion forums and data annotation, both of which will be provided via a web-accessible portal.

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*Data Systems*

Development of data collection and storage tools have been given highest priority, as preliminary discussions with ITOP investigators indicated a strong desire for a system that had at least the capabilities of NCAR's Earth Observing Laboratory (EOL), which is primarily a system for aggregating and presenting externally generated products. However, ITOP researchers also want to have binary field data and model outputs in a place where the program investigators can easily manipulate the data.

After binary data is collected, it must be either converted to a common format or otherwise handled via a common mechanism that provides consistent metadata. In the 2003 and 2006 AOSN field programs data was converted to a common format -- this approach was found to be reliable, but doubled data storage requirements and complicated versioning and management of data. The approach for ITOP will be to leverage UCAR's NetCDF library to "wrap" raw binary files so they look like CF-Metadata compliant NetCDF files.

A critical capability identified in 2003 and 2006 as desirable in future field programs are tools that allows investigators to identify and describe new data streams so they can be integrated into the system, and tools that monitor the progress of the system in real-time, ensuring that data products were being collected at the right time, and notifying users of any problems in the process. Our approach for ITOP includes such capabilities.

An active area of AOSN research, funded by both ONR and the Packard Foundation, is the data discover and data access tool called the Metadata Oriented Query Assistant (MOQuA). Our approach is to incorporate MOQuA features into the ITOP collaborative tool suite.

Investigators from both the AOSN and ITOP consider periodic standard visualizations to be one of the most desirable features to include in an experiment's data system. However, many expressed a desire to perform ad-hoc visualizations within the context of the data system. The approach for ITOP will include both standard, periodic visualizations and ad-hoc visualization capabilities.

*Collaborative Tools*

Our approach to designing the human collaboration systems has begun by examining how ITOP investigators make operational decisions in the ITOP pilot experiment. As this process continues in the ITOP virtual experiments, we will refine the collaborative tool approach. Nevertheless, we have some initial ideas which will be prototyped in the virtual experiment.

On-line discussion was the core of the COOP system, and its many forms (general discussion, daily summary, proposals, and voting) were facilitated though the on-line discussion system. Our approach to on-line discussions will enhance the COOP toolset with search tools and the capability to pivot discussion threads off of a variety of themes.

Falling midway between on-line discussion and data visualization, our approach will include an annotation system that allows investigators to tag data with comments, so that others that explore the same data collections can learn from the experience of others, as demonstrated in the Figure 1 mock-up.

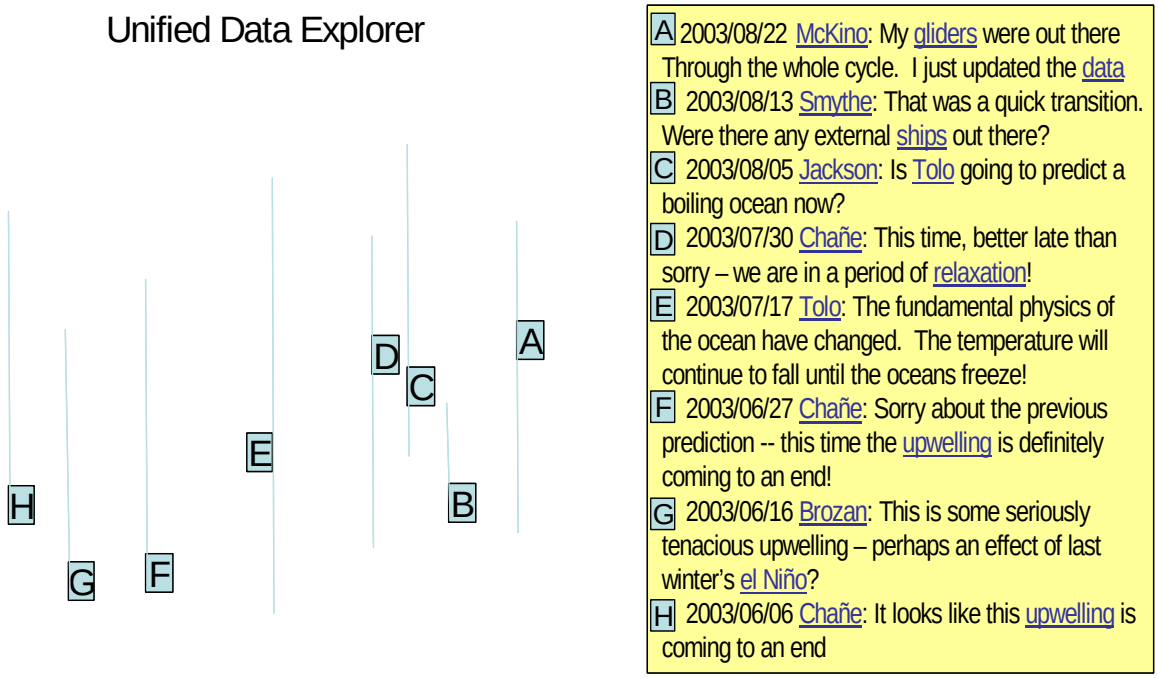


***Figure 1, Example Data Annotation Mock-Up***

A major lesson learned in the ASAP experiment was that investigators are often located in places (ships, for example) where they cannot interact with an on-line portal. Many investigators are also more comfortable with e-mail than on-line portals. Therefore, our approach will allow investigators to contribute to discussions via e-mail, and receive updates and alerts via e-mail.

**WORK COMPLETED**

The first versions of the Collaborative Science portal (CoSci) were released in September 2009 at http://itop.orc/cosci (see Figure 2). As requested by ITOP PIs, this system duplicates many of the features of NCAR's Earth Observing Laboratory (EOL), but also contains improvements over EOL, such as an internal architecture which will allow it to evolve into a collaborative communication tool. During September 2009, the prototype system collected over 100,000 model and observational products from repositories around the world.

CoSci offers on-line editing of the data repository by non experts through an administrative portal. As shown in Figure 3, the administrative portal has allowed a user to specify a product from Dong-Shan Ko's EASFNS model for inclusion in the repository, by simply indicating the URL of the files to be

included (as a regular expression), followed by the username and password for Ko's site, and information on how to understand the dates embedded in the file name of each product.

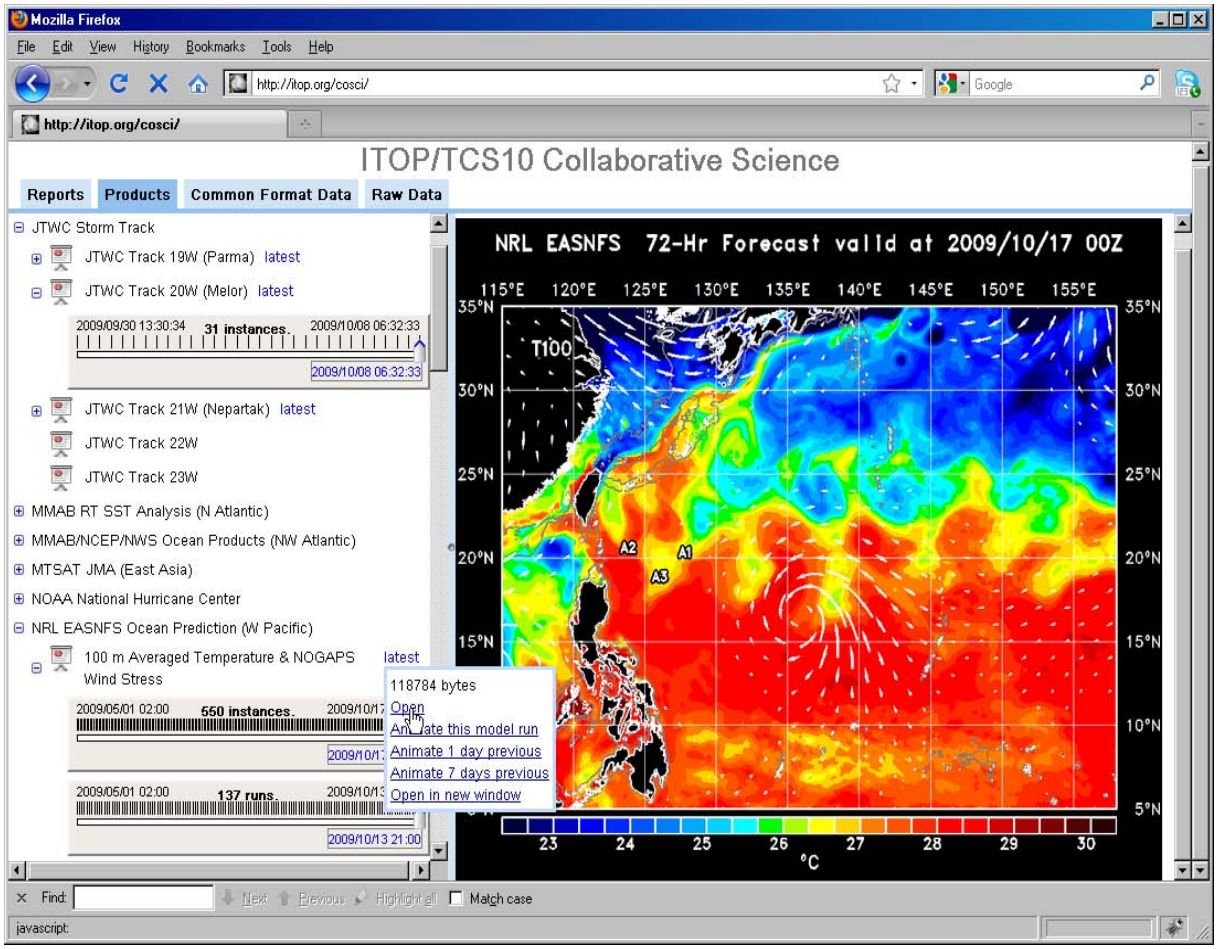


***Figure 2, ITOP Collaborative Science (CoSci) portal prototype, showing latest instance of Ko's EASNFS model forecast product.***

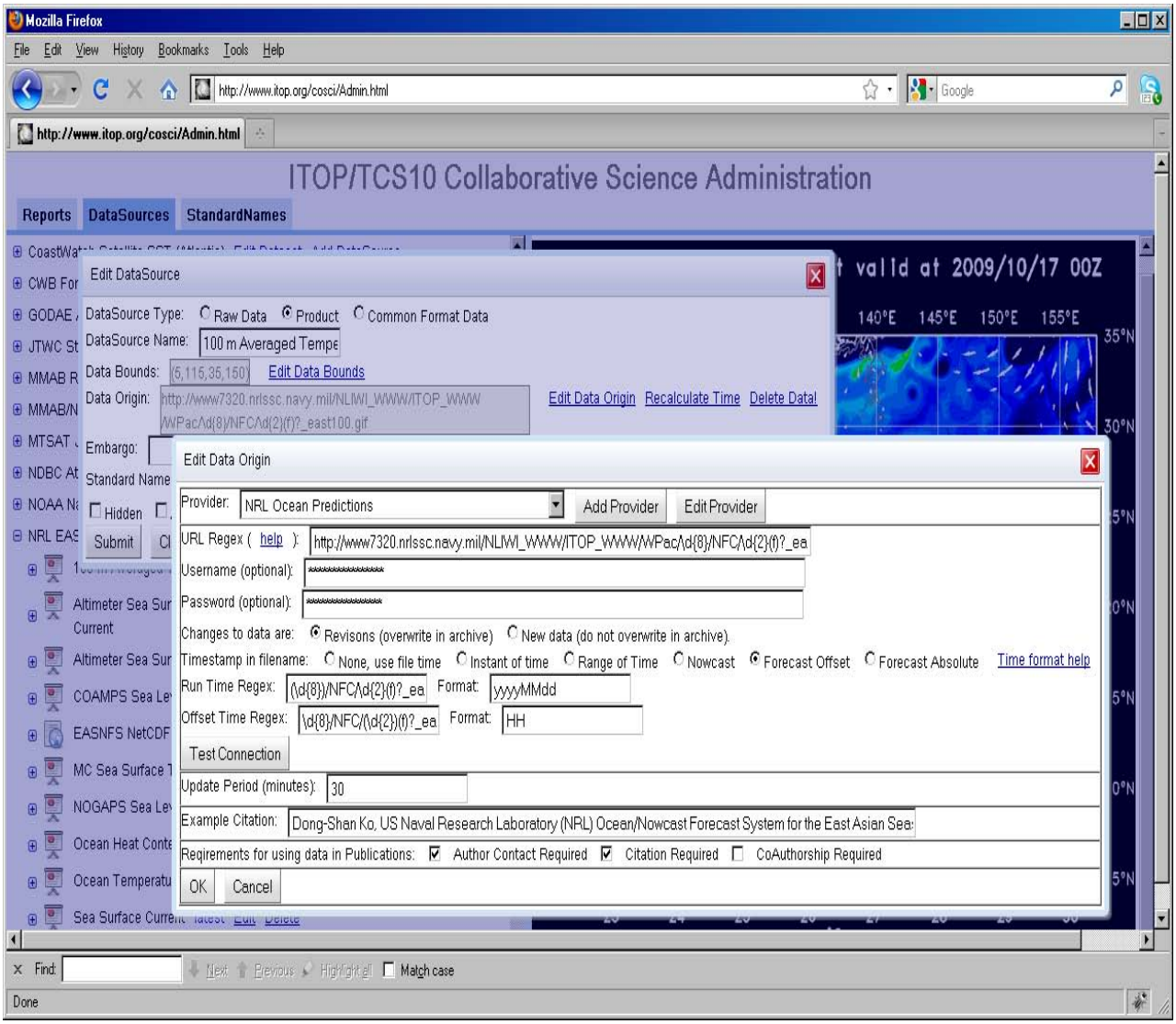


***Figure 3, CoSci administrative tools, shown editing an entry for an EASNFS forecast product.***

## RESULTS

We have learned, in the first ITOP pilot experiment, that the preliminary decision-making process is primarily top-down, coming from a small cadre of co-located researchers, rather than widely consensus-based as it was in the ASAP experiment. However, a majority of program participants have yet to weigh in on the decision making process, and the virtual experiments have yet to begin. Nevertheless, it appears that the tools we will be providing may be *decision influencing* tools, which would help far-flung researchers impact the centralized decision making process, rather than *decision support* tools, which would be used to garner consensus decisions.

Also, in the implementation of the ITOP pilot experiments, a strong preference was shown for "live" web meetings, rather than the asynchronous "discussion forum" style communications that characterized the ASAP experiment. However, current technology (primarily screen sharing) it

bandwidth intensive, making participation in live web meetings awkward for many remote participants. This is encouraging us to develop collaboration features that enhance the capability of users to participate in web meetings without requiring that participants have unlimited bandwidth.

The implementation of CoSci web application runs entirely on compute cloud infrastructure, meaning that no hardware investment has been necessary, and no hardware maintenance will be required in the future. A small monthly bill covers the cost of compute cycles on the virtual server hosting the application, the cost of data transfer to and from the server, and the cost of data storage. Most importantly, running CoSci in the "cloud" means that duplicating the system for another field program would take hours, rather than months that would be required to procure, install, and configure a physical server.

## IMPACT/APPLICATIONS

The success so far with CoSci has shown that for future field programs and observatories, ONR will have the option of quickly and easily deploying CoSci portals.

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